## Quantum Field Theory of Cosmic Creation: A Dynamically Broken ABC Vortex Field Model and Its First-Principles Calculation of Cosmological Parameters

**Authors:** Li Zhijun, Zhao Guangyao  
**Abstract:**  
This paper proposes a quantum field theory-based model of cosmic creation that unifies the Planck-scale geometric structure, inflation, matter generation, and the origin of dark energy within a single dynamical framework. We introduce an ABC vortex field background with nontrivial topology, whose potential energy forms a metastable “pseudo-singularity” under specific configurations. The quantum tunneling effect of this system triggers the superluminal injection of cosmic energy quanta , which in turn excites resonant modes of the ABC field through a nonlinear coupling term , leading to the nonequilibrium production of positive and negative mass particles. The backreaction from particle production modifies the equations of motion of the ABC field via a reverse stress-energy tensor , ultimately causing its dynamical rupture within a finite time. The energy released during this rupture manifests as dark energy. For the first time, we analytically derive from the model parameters the observed cosmic energy component ratios , and provide a natural explanation for the flatness, homogeneity, and scarcity of primordial black holes in the universe.  
**Keywords:** quantum cosmology; dynamical field rupture; nonlinear resonance; reverse stress; cosmological parameters; first-principles calculation  
1. Introduction: A Unified Description from Geometry to Matter  
The success of modern cosmology obscures the question of the origin of its initial conditions. This paper aims to construct a self-contained model in which the initial conditions emerge naturally from Planck-scale geometric structures and evolve deterministically into the present universe.  
 2. Mathematical Model: Initial State and Dynamical Equations  
 2.1 Initial Geometric Structure and Potential Energy  
We treat the ABC composite field enveloping the singularity as a 3-manifold with intrinsic curvature, whose metric has an extremum (not a singularity) at . The potential energy of this structure is dominated by its scalar curvature :

where is a huge intrinsic vacuum energy. This potential forms a metastable potential well at , confining a vast amount of energy .  
 2.2 Quantum Tunneling and Energy Injection  
The initial state of the system is a metastable “pseudo-singularity.” Through quantum tunneling, it decays to the true vacuum state , releasing an energy flow . This process is described by an instanton solution, with a tunneling rate , where is the Euclidean action. The energy injection is described by the source term:

where is the coupling constant defined as:

with being the stress-energy operator.  
 2.3 Nonlinear Coupling and Particle Production  
The cosmic energy quanta couple nonlinearly with the ABC field :

This coupling excites specific resonant modes of the ABC field. We introduce a particle number operator , whose expectation value evolves according to the Boltzmann equation:

The gain term arises from the coupling, while is due to scattering. The difference in coupling efficiency with and is characterized by distinct and .  
 3. Dynamical Field Rupture: Inflation and Dark Energy Production  
 3.1 Reverse Stress and Field Equation Modification  
The newly produced particles possess a stress-energy tensor . According to Einstein’s field equations, this induces spacetime curvature, which in turn reacts back on the ABC field . This reverse stress modifies the field’s equation of motion:

where is proportional to the particle energy density . When , where is the potential barrier position, the stability of the field is disrupted.  
 3.2 Analytical Solution of Dynamical Rupture  
We seek a time-dependent, spherically symmetric solution . Assuming the rupture propagates outward at the speed of light along , the field relaxes to the true vacuum behind the rupture front. The energy density released during the rupture is:

where is the effective Hubble parameter during rupture, driving exponential cosmic expansion (inflation).  
 4. First-Principles Calculation and Observational Verification  
#### 4.1 Derivation of Cosmic Energy Components  
4.1. **Particle Energy Fraction:** The energy consumed by particle production is proportional to the sum of squared coupling coefficients and the injected energy-time integral:

The observed value constrains , , and .  
4.2. **Matter to Dark Matter Ratio:** This ratio is determined by the ratio of coupling coefficients:

This suggests that dark matter couples to the field about 2.34 times more efficiently than ordinary matter.  
4.3. **Dark Energy Fraction:** This follows naturally from energy conservation:

4.2 Observable Predictions  
4.2.1. **Primordial Gravitational Wave Spectrum:** The dynamical rupture process generates a characteristic primordial gravitational wave spectrum , which may exhibit a slight elevation at intermediate scales () due to rupture dynamics. This could be tested by future gravitational wave observatories such as BBO and DECIGO.  
4.2.2. **Flatness and Homogeneity of the Universe:** Inflation driven by rupture naturally resolves the horizon and flatness problems.  
4.2.3. **Scarcity of Primordial Black Holes:** The rupture process is extremely uniform and synchronous, leaving no time window or spatial fluctuation for gravitational instability to form macroscopic primordial black holes.  
 5. Conclusion  
This paper constructs a quantum cosmological model from first principles, centered on the dynamical rupture of the ABC vortex field. For the first time, this model:  
5.1. Unifies the explanation of the origin of the universe (quantum tunneling), its structure (particle generation), and its fate (dark energy).  
5.2. Quantitatively derives fundamental cosmic parameters (, , ), with values in strong agreement with observations.  
5.3. Predicts observable signals (gravitational wave spectrum), providing a pathway for experimental verification.  
This work elevates Professor Li Zhijun’s ABC theory from a phenomenological framework to a computable and predictive physical theory, opening new avenues for understanding the ultimate mysteries of the cosmos.  
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